Coordinated Freeway and Arterial Street Operational Strategies and Procedures

Chapter 4

Operational Strategies Evaluation And Corridor Improvement Plan

Draft

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Table of Contents

4 OPERATIONAL STRATEGIES, EVALUATION, AND CORRIDOR IMPROVEMENT PLAN

4.1 PURPOSE

This chapter presents steps 5, 6 and 7 of the Coordinated Freeway and Arterial Operations Framework presented in Chapter 3. The framework is repeated in Figure 4-1 below for reference.

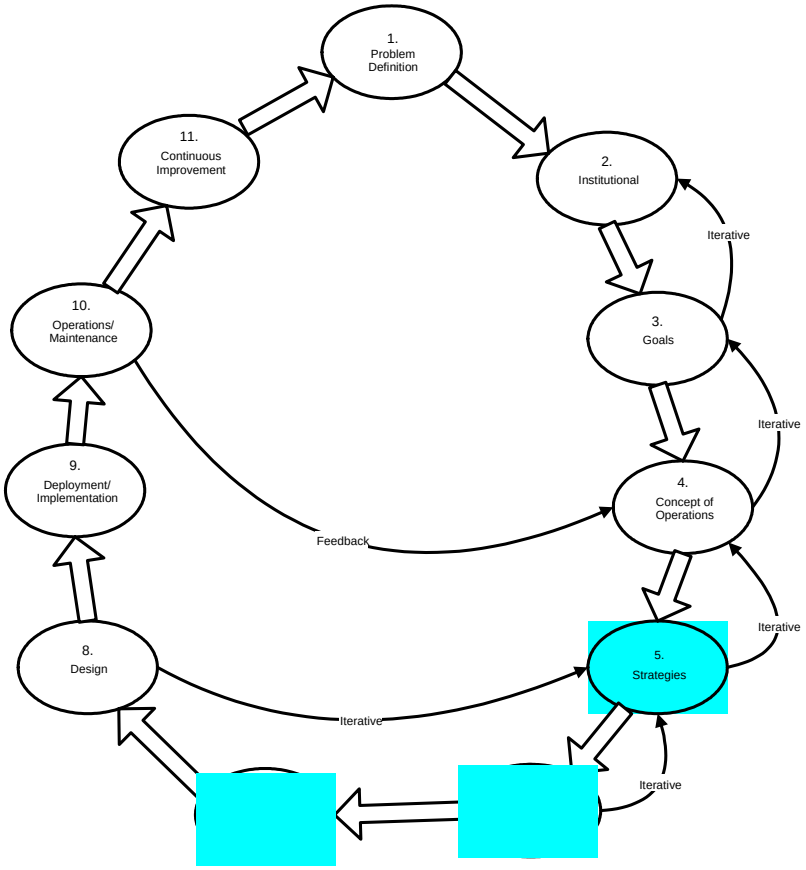

Figure 4-1 Coordinated Freeway and Arterial Operations Framework

The steps to be covered in this chapter are:

5. Strategies
6. Evaluation/Selection
7. Corridor Plan

This chapter builds on the Concept of Operations, the final product of step 4 Coordinated Freeway and Arterial Framework, which was presented in Chapter 3. The high-level Concept of Operations which was developed in the first three steps of the framework (Problem definition, Institutional Framework, Goals) provides the general understanding of the scenarios (congestion causing events) which may be mitigated by implementing strategies to improve corridor operations. The Concept of Operations may a formal stand-alone document at the end of step 4 and/or a part of the Corridor Plan. The Corridor Plan is the formal product of the three steps (5,6, and 7) of the Coordinated Freeway and Arterial Operations Framework (Figure 4-1) discussed in this chapter. This chapter is a stand-alone chapter because discusses the more detailed aspects of the corridor plan which includes development and evaluation of alternative strategies to respond to scenarios in the Concept of Operations. Up to this point, the process has been high-level, policy oriented, and focused on determining what goals can be jointly pursued and a high level understanding of how the goals might be achieved. The Concept of Operations represents the culmination of a process to build consensus on what a coordinated freeway and arterial program would do by developing scenarios that the operating agencies can agree warrant the implementation of appropriate strategies. This chapter focuses on the more detailed Corridor Plan, which is necessary to plan an implementation program and secure funding.

In this chapter, the strategies will be evaluated and selected in order to develop the Corridor plan. The Concept of Operations is essentially taken to the next level of detail, development of strategies to mitigate the scenarios developed in the Concept of Operations. The Corridor Plan is a document, which can be used, in the regional planning process to obtain funding for design and implementation of projects necessary to achieve the corridor management goals.

This chapter provides an overview on potential strategies to improve corridor operational performance through the development of specific control plans as part of an overall corridor improvement plan. The types of operational problems include those arising from a variety of intermittent events (incidents, work zones, and special events), as well as the recurring day-to-day events that result in less than desirable operations for travelers using a corridor involving multiple jurisdictions and agencies responsible for system operation.

Typical categories of operational strategies include:

- Traveler Information
- Traffic management and control
- Shared information and resources

These strategies will be described in more detail in Section 4.4.

The Corridor Plan will be discussed in Section 4.6. The Corridor Plan includes:

- Roles, responsibilities, and procedures
- Activation criteria
- Infrastructure needs and costs
- Operating resources and costs
- Maintenance requirements and costs
- Implementation priorities and schedule
- Updating process.

4.2 KEY ISSUES

The strategies that are available for coordinated corridor operations are not significantly different from those available to individual agencies. They do, however, require a larger view of the system that focuses on the travelers needs as the primary focus of operational strategies, consistent with individual jurisdictional needs and policies. Creating an institutional framework and environment that fosters collaboration and coordination is the key challenge in achieving success.

In this chapter, the focus is moving from a Concept of Operations to a detailed Corridor Plan. In order to achieve level of detail necessary to develop a Corridor Plan involves bringing together the appropriate stakeholder technical staff.

4.3 DEVELOPMENT AND SELECTION OF STRATEGIES

Coordinated freeway and arterial operations apply many of the strategies used by individual agencies in a broader context in order to provide improved system performance. It deals with the integration of different control concepts such as traffic signal control and ramp metering, which are often under different jurisdictional control

Figure 4-2 presents a simple graphic summarizing the two dimensions of the coordinated freeway and arterial environment. Across the top are the various potential applications. Across the side are the categories of strategies. Many of the strategies apply across multiple applications that are they are not unique to specific application. However, the implementation of the strategies have unique aspects based on the application.

The remainder of this chapter will present additional detail on steps 5, 6 and 7 of the coordinated freeway and arterial framework. Details include the various strategies that can be applied, a discussion on the methods of evaluation, and other details regarding the corridor plan. In these steps, the high-level scenarios are amplified. The scenarios form the basis to develop and evaluate specific strategies that might be implemented to achieve the goals developed as part of the Concept of Operations. The process of developing, evaluating and selecting strategies is iterative. That is a strategy that is initially selected for consideration, may be unacceptable when its performance is evaluated or when it is determined that the necessary resources are beyond those available and/or that might be secured in the future.

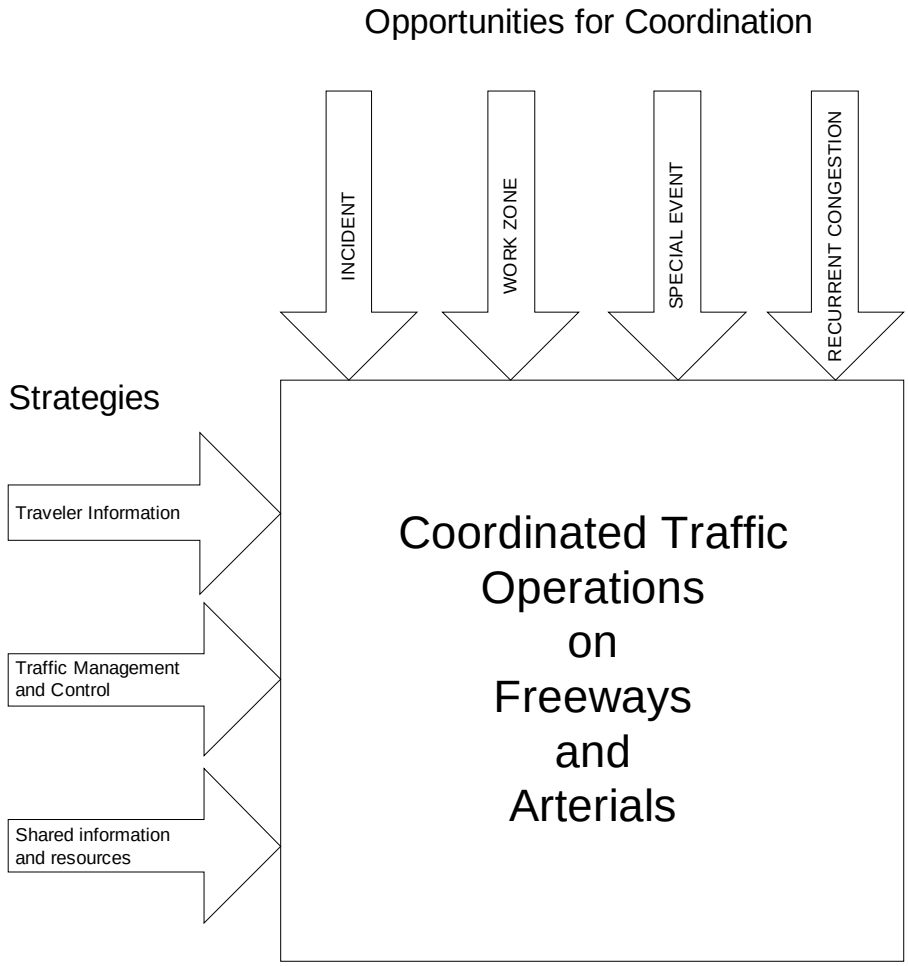

Figure 4-2: Relationship between strategies and opportunities

4.4 DEVELOPMENT OF STRATEGIES

Step 1 of the corridor traffic management framework identified a problem, which ultimately leads to establishment of an institutional framework in Step 2, establishment of Goals in Step 3, and finally to a Corridor Concept of Operations in Step 4, all of which were discussed in Chapter 3. The corridor concept of operations would identify one or more opportunities for coordination as shown along the top of Figure 4-2. The corridor concept of operations would include one or more high level scenarios that would describe how the event causing corridor congestion might be mitigated through one or more high-level scenarios. The specific strategies (traffic management and control, traveler information, and shared information and resources) to implement the high-level scenarios is the focus of this section.

Figure 4-3 shows the information flows (which are essential the relationships between the various control and information systems, and the opportunities for coordination) necessary to support corridor traffic management strategies. Corridor traffic management integrates the operations of freeway and arterial control systems for the benefit of overall corridor operations. It shares information with the appropriate agencies and private sector providers of traveler information in order to implement various strategies to mitigate congestion.

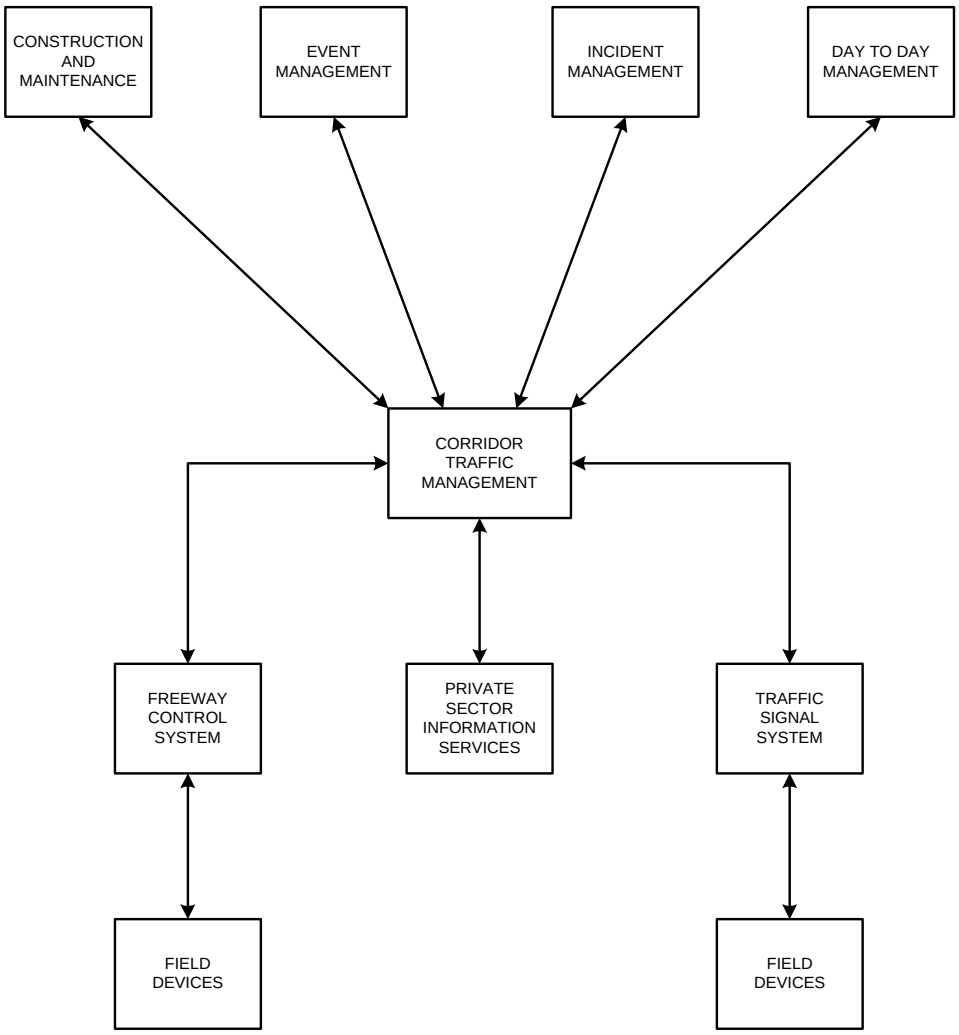

Figure 4-3 Example of Corridor Traffic Management Information Flows

In order to achieve effective corridor traffic management requires bringing all the responsible agencies together who are involved in the process as either providers of or users of the information (implementers of strategies) necessary for effective coordination of freeways and arterials.

As will be seen in the example below, the potential strategies require a potential diverse set of resources to be involved in the implementation of the strategies. The agency staff required to be involved in the refinement of the strategies is likely to grow as the strategies are refined. For example, the fire department may not be involved in the initial development of the high-level scenarios. However, when it comes time to develop and implement an incident management strategy, their involvement becomes essential.

As an example, the problem described in the Concept of Operations might be incidents on a freeways causing congestion despite the presence of motorist service patrols. The high level scenario that is developed includes a more coordinated response of emergency management agencies, and providing traveler information on a parallel arterial to discourage additional traffic from entering the freeway. The scenario might also include preferential traffic signal timing along the parallel arterial corridor to expedite movement to an alternative entrance ramp downstream of the incident where the ramp metering rate has be increased or the meters shut off to improve access downstream of the incident.

The purpose of refining the scenarios is to engage the appropriate agencies and their staff in order to provide sufficient detail to understand the details of the strategies. The process is iterative because of the need to understand the relationship between the benefits and the resources required to implement the strategies. The Corridor Concept of Operations has only a high level description necessary to achieve management buy-in to the program. The Corridor Concept of Operations is not sufficiently detailed to take the project to the design and implementation stage because it is not specific enough concerning the details of the strategies nor the cost of implementation. The engagement of technical staff is necessary in order to develop the Corridor Plan.

In developing the strategies and associated scenarios, a variety of options exist. Along the left side of Figure 4-2 are three general categories of strategies that can be applied to one or more of the congestion causing events. The next section will provide more details on the candidate strategies for consideration.

4.4.1 Traveler information

Traveler information (or the absence of traveler information) can have either positive or negative effects on system performance. A freeway dynamic message sign can potentially having a negative impact on a parallel arterial if appropriate traffic management and control plans do not support the potential response to the information. The important point to be conveyed in this section is the need for a coordinated freeway AND arterial view of traveler information.

Examples of traveler information include:

- Web pages
- Pagers/ personal data assistants (PDAs)
- Telephones/511
- DMS signs (fixed and portable)
- Commercial radio broadcast
- Commercial TV broadcasts
- Highway Advisory Radio
- CB Radios
- Dynamic route guidance signs
- Kiosks

Traveler information is provided through formal and informal sources. Informal sources include the use of CB radios by truckers. Formal sources include government provided DMS signs and private sector traffic information providers including radio traffic services. By expanding the quality and extent of information, system performance can be improved by travelers re-routing or deferring trips.

A coordinated view has two benefits. First it makes sure that traveler information does not have a negative impact on the system by focusing on only one part (the freeway OR the arterial). Second, it focuses on traveler information as a system approach to maximize corridor performance. During peak traffic times, traveler information may delay or even cancel trips, reducing the demand during peak times. During off-peak times, traveler information may make better use of the system by allowing lesser used portions of the system to take up the excessive demand on a portion of the system experiencing some form of non-recurring congestion.

A coordinated traveler information strategy includes shared use of information systems. For example, a dynamic message sign typically only used to provide freeway traffic information could also provide information on congestion on nearby streets caused by incidents or special events. Without a broad view of traffic management, the freeway DMS sign does not achieve its maximum potential as a traveler information system.

Traveler information can be provided in various ways. Critical aspects of information include time of information (pre-trip, en-route), type of information (condition vs. guidance), the extent of the information (link-based, or corridor-based) and the method of dissemination (website, radio, highway advisory radio (HAR), dynamic message signs, or static/dynamic trail blazers. The more system focused (corridor versus link) the information, the better the decisions those travelers can make.

The further in advance information can be provided, the more likely a desirable outcome. Before leaving home or work, the alternatives are significantly greater than when caught in traffic. A coordinated traveler information strategy would desirably use a single metropolitan area web site with both freeway and arterial travel information. Estimated travel times could be provided for alternative routes, along with information on events along either route. During the middle of the day, work zone activities could be provided on the corridor traffic map indicating the nature and location of work zones.

Improving the type of information is also important. Traditionally, because of the lack of coordination between operating agencies, traveler information was largely advisory and only related to the agency owning the DMS sign. By developing agreed upon response plans, guidance information can also be provided to help travelers understand specific options.

To achieve a corridor approach to traveler information requires a broader look at available systems and the interconnections necessary to implement the corridor information program. Issues that may need to be addressed include center-to-center communication and shared control of traveler information systems such as web sites and DMS signs. Such a coordinated traveler information program may require the development of memorandums of understanding and/or more formal agreements. These are the types of details necessary for implementation. Such details would be finalized in the design phase (Step 8 of the Corridor Traffic Management Framework.

Phoenix, AZ
State DOT can control City DMS signs

4.4.2 Traffic Management and Control

Traffic management and control strategies are divided into three categories for discussion:

- Coordinated Traffic Signal Timings
- Lane Use Adjustments
- Access Control

4.4.2.1 Coordinated Traffic Signal Timings

Traffic signals are operated by the responsible jurisdiction or its designee. The boundaries of these operating agencies often do not constitute logical break points in a traveler's journey. Therefore, one simple means of improving corridor operation is to jointly develop timing plans in a way that reflects a system view of travel.

Traffic Signal Coordination
Between agencies
Between freeway and arterial
In response to events
With ramp meters

The simplest example of coordinated operations is expanding traffic signal timing issues beyond individual agency boundaries. This can be accomplished in many different ways depending on the specific situation. There are many acceptable answers (and one undesirable answer -- no coordination) to achieving the user-focused operation.

Perhaps a city has all the traffic signals approaching an interchange and the state operates the two traffic signals at the interchange. The state traffic signals could be added to the city system for coordination purposes by simple extending the traffic signal interconnect if the agencies have compatible equipment. Such an arrangement does not require one agency to give up control; it is only necessary to allow another agency to provide the necessary coordination functionality. The technical issues include provision of the necessary communications infrastructure and agreement on the coordination timing parameters. Institutional issues include development agreements, if necessary, and development of procedures to address how the two agencies address any operational and maintenance problems that may arise.

City of Scottsdale
Has developed pre-arranged timing plans to be implemented in response to freeway incidents

The means for implementing cross-jurisdictional traffic control can very from simple agreement to operate a common time reference, cycle length, and offset, to more sophisticated integrated systems. The more sophisticated the timing strategies, the more sophisticated the traffic control system needs to be.

For example, peak-hour coordination can easily be achieved using pre-arranged timing plans using a common reference time. Pre-planned incident response plans can be implemented in a number of ways including simple telephone calls to the collaborating agency or by granting limited control access to the collaborating agency, especially when one agency has 24 hour/7 day a week operation and the other does not.

A more detailed discussion of cross-jurisdictional signal coordination can be found in Appendix XX (Cross Jurisdictional Signal Coordination in Phoenix and Seattle.

As the control plans become more complicated or require ad hoc adjustment, the control system must be more tightly integrated. More integrated systems can be either distributed or through a shared operations center. Additional information on technology issues are addressed Chapter 9.

Another boundary between subsystems occurs between freeway control systems and arterial control system. These boundaries can cause operational problems because of uncoordinated day-to-day operations or as a result of non-recurring congestion affecting normal traffic. Traveler information on one system can have impact on the other, and control decisions on one system can have impact on the other system. Several examples will be given in the following paragraphs.

Traffic signal control on an arterial may favor arterial coordination over exiting traffic and have no information on the impacts of the signal timing on freeway operations. A more integrated system would provide feedback to the arterial control system about excessive queues spilling back on the freeway.

Another example of subsystem interaction is ramp metering. Ramp metering considered in isolation from adjacent signal timing can adversely affect both the ramp metering and the traffic signal operation. If the traffic signal discharges excessive traffic into the ramp, the meter may have to go to less restrictive metering to discharge the queue, reducing the effectiveness of the ramp metering. If restrictive ramp metering backs up traffic onto the arterial, arterial operations may suffer, negatively impacting the overall system performance.

A study by FHWA[1] indicated that ramp and traffic signal coordination improves traffic conditions within the corridor. Strategies used included local, area wide, diversion and congestion strategies.

Local Coordinated Strategy This mode of operation implies the need for a close and responsive interaction between the ramp meter controller and the traffic signal controller. The ramp-metering rate is adjusted base on the current traffic signal timing at the interchange. Signal timing may also be modified based on current ramp metering rate, which ever is more critical at that moment.

Area wide Integrated Strategy This strategy is a traffic-responsive type, setting metering rates based on corridor flow rather than local conditions at the interchanges. The area wide strategy also requires frequent adjustments in traffic signal timing plans as well as ramp metering rates in order to react to short-term stochastic changes in traffic flow.

Diversion Strategy The strategy is designed to handle incidents. The strategy assigns special timing plans to both the arterial traffic signals and the ramp meters at locations affected by the diversion strategy.

Congestion Strategy When traffic demand exceeds capacity in a portion of the corridor, the objective of the traffic control strategy will be to mange the spread of congestion rather than the demand. The goal is to minimize the effect that the congestion has on the overall system performance by controlling the location of queues that potentially have significant adverse effect on traffic.

4.4.2.2 Lane use adjustments

Lane use is often set up based on peak-hour traffic and prescribed by static signing. This approach generally meets routine needs, but is not responsive to changing. At locations with changing traffic conditions special events or at locations, which may serve traffic from non-recurring events such as incidents, dynamic lane assignment signs may be an appropriate treatment.

The picture at the right illustrates a dynamic lane assignment location on a freeway frontage road. The location could also be a more typical freeway ramp to an arterial where the normal operation is a single lane turning right. Under a coordinated freeway and arterial management strategy event (incident, work zone or special event) the right turn could be converted to a double right turn. The strategy would only be effective if the receiving roadway network was timed to accept the extra traffic caused by the event. This type of strategy could also be used during different times of the day to reflect different traffic patterns.

These changes might be routinely implemented by time of day to respond to hourly variations in traffic, or with appropriate control systems, could also be used for non-recurring events in order to improve corridor operations.

Lane use control can also be provided on freeways to improved incident management, traffic flow. or to improve merging capacity as show in Figure 4-4. These techniques can be used to expedite flow on to or off-of freeways as part of a coordinated freeway and arterial management strategy.

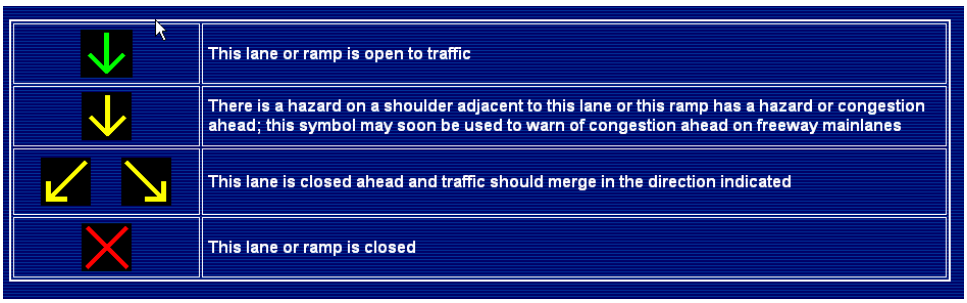

Figure 4-4 Freeway Lane Control Signals

The important issue is to understand that effective lane use should represent current traffic demands when traffic in a corridor is often at or near capacity, not an average traffic conditions. In order for lane use to be most effective, it should be part of a coordinated freeway and arterial traffic management strategy.

4.4.2.3 Access control

Access control can include turning restrictions, ramp metering, or even ramp closure. While ramp metering is an example of limited access control, as are turn restrictions, a variety of measures can be taken to restrict access. Gates on either entrance or exit ramps to or from freeways are a means of controlling access. This can be done using traffic control devices that are deployed on a temporary or a permanent basis.

Coordinated freeway and arterial management takes access control to the corridor level. At the corridor level, the perspective is the most effective use of available traffic capacity. The available capacity may vary by time of day and more importantly, the strategy that is most effective will depend up the scenario being addressed.

4.4.3 Shared information and resources

The previous two sections (4.4.1 and 4.4.2) dealt with coordinated information systems and coordinated traffic management and control. Sharing information and resources takes system to a more complete level of integrated corridor operations. Sharing can involve all types of information and resources.

Perhaps the simplest examples of sharing would involve sharing of information. An example would be incident report from a freeway traffic management system, which could provide insight into potential traffic diversion to parallel routes. The sharing of surveillance cameras to that another agency could make use of the equipment for gathering information. For example, a freeway surveillance camera at an interchange could provide the arterial management agency information on street conditions without the need to invest in their own camera.

Other resources that could potentially be shared include various incident response equipment including service patrol, wreckers, portable DMS, etc. A possible application would be during a special event where one agency may not have sufficient assets to adequately address the needs.

Shared operations might involve an agency with a 24 hour/7 day a week operation being given operational control during hours when another agency does not man their operational center. Limited functionality might even be given to a non-traffic agency during hours where the traffic agency does not staff their traffic operations center.

4.5 EVALUATION AND SELECTION OF STRATEGIES

The structure and formality of the evaluation process used to assess the costs and benefits of the alternatives will depend on the complexity and coordination needs of each agency. The evaluation also needs to reflect the evaluation and selection process already in use by agencies for other types of program development. The evaluation process and criteria should also reflect the goals and objectives established in step 3 or the Coordinated Freeway and Arterial Operations process in Figure 3-1.

It is important to realize that when the management techniques require the cooperation and support of multiple agencies, the evaluation technique chosen should also reflect the likelihood of getting the cooperation of the affected agencies.

System performance can be improved by reducing four aspects of congestion:

- Duration (the amount of time system is congested)
- Extent (geographic distribution of congestion)
- Intensity (total amount of congestion
- Reliability (variation in amount of congestion)

Generally, congestion has been addressed at the single roadway level. Coordinated freeway and arterial operations expands the evaluation framework to the corridor level. Example measures of effectiveness include:

- Hours of operation below an acceptable speed
- Miles of congested road
- Per cent of VMT in congestion

For large or complex projects, simulation models (TSIS, VISSIM, SimTraffic, etc) can be used to assess alternative strategies or estimate the benefits of more expensive implementation programs. More modest projects like signal coordination can be estimated at the planning stage based on the experiences of others.

It should also be realized that coordinated operations cannot be achieved in a single stroke. A modest program that starts small and builds on success is more easy to start and more likely to be successful. Success makes it easier to sell more expensive efforts based on the demonstrated results of earlier efforts.

Other issues may also be evaluated in a qualitative or quantitative manner including:

- Safety
- Mobility
- Economic development

The selection of alternatives needs to reflect the current state of coordinated operations, as well as the long-range vision of corridor traffic management. To achieve the greatest synergy, the selection process should reflect those strategies that produce the most benefit in aggregate. The result of this step is the specific strategies recommended for implementation. Further details regarding implementation are discussed in the next section.

4.6 CORRIDOR PLAN

The corridor plan provides sufficient detail to take the projects to detailed design and implementation. The corridor plan also provides the basis to secure funding for design and implementation. The corridor plan provides the complete program of projects necessary to achieve the vision and goals for the corridor. It identifies the specific projects to achieve the overall corridor traffic management program as well as their costs and priorities for implementation.

Another value of the corridor plan is it plan is it provides a record of the process. As staffs change, the plan provides the necessary details that allow others to pick up the plan and not have to revisit the steps leading up to the plan. This does not mean that the plan needs so to static. Plans will always need to be updated based on changing circumstances. In fact, the last step in the corridor traffic management framework is continuous improvement.

The corridor plan is likely the second formal document produced from the corridor traffic management framework. It would include the Corridor Concept of Operations, which is the conceptual basis for the plan. The Corridor Concept of Operations is the enabling document developed in Step 4 that allows the collaborating agencies to define what actions in general terms they would be willing to undertake to achieve improved corridor operations. Steps 5 and 6 which have been described in this chapter lead to the selection of the to be incorporated into the corridor plan. However, to have sufficient information to advance projects to design, implementation and operation requires additional detail.

The corridor plan would include the following elements:

1 Goals and objectives

2 Concept of Operations

3 Performance measures

4 Scenarios with operational strategies

5 Roles, responsibilities, and procedures

6 Activation criteria

7 Infrastructure (capital) needs and costs

8 Maintenance requirements and costs

9 Operating resources and costs

10 Implementation priorities and schedule

11 Updating process

The first four items are the result of the first six steps of the coordinated freeway and arterial framework (Figure **4-1**). Items 5 through 11 are the remaining items needed to complete the corridor plan.

4.6.1 Roles, responsibilities, and procedures

Coordinated operations by its nature requires that roles and responsibilities be defined, as well as the procedures to implement the roles and responsibilities. The formality of the definition of the organizational relationships will depend on the complexity of the strategies and the legal requirements of the organization.

The types of issues to be resolved include:

- Who owns
- Who maintains
- Who controls (primary, secondary, none)
- Who shares (data or video)

4.6.2 Activation Criteria

The activation criteria will generally be part of the scenarios. Table 4-1 is an example of the type of criteria that might be used to determine when the strategies for a particular scenario are to be activated.

Table 4-1 Example of Activation Criteria

Factor	Criteria
Number of lanes blocked	Two or more
Duration	20 minutes or more
Time of day	Peak period
Day of week	Weekdays
Volume of traffic	Heavy

4.6.3 Infrastructure and capital costs

Although some operational improvements are possible using existing infrastructure, some capital expenditures are likely to be required to implement a coordinated freeway and arterial operations program. Infrastructure items need to be identified and their cost estimated in order to secure funding for design and construction.

The development of coordinated freeway and arterial management and operations is facilitated by The National ITS Architecture (see: http://www.iteris.com/itsarch), which provides a tool for achieving integrated transportation operations. Within the framework is a data flow process called traffic control coordination ITS function is information transfers that enable coordinated operation of traffic management devices. The objective is to allow cooperative access to, and control of, field equipment during incidents and special events and during day-to-day operations. It also allows 24-hour centers to monitor and control assets of other centers during off-hours, allows system redundancies and fail-over capabilities to be established, and otherwise enables integrated traffic control strategies in a corridor

Examples of infrastructure needs to support corridor operation include:

- Communications between systems
- Field equipment upgrades to facilitate integration
- Additional surveillance
- Additional detection
- Additional DMS
- Minor geometric improvements

4.6.4 Operating resources and costs

The implementation of new infrastructure may require additional operating costs (personnel and/or material and supplies and/or other costs). In order to sustain a coordinated freeway an arterial operations program requires that operating costs be funded from agency budgets.

4.6.5 Maintenance requirements and costs

The implementation of new infrastructure may require additional maintenance costs (personnel and/or material and supplies). In order to sustain a coordinated freeway an arterial operations program requires that maintenance costs be funded from agency budgets. Without a commitment to operations and maintenance, an infrastructure program should not be undertaken.

Table 4-2 is an example of how all the costs might be summarized in a Corridor plan.

Table 4-2 Examples of Capital, Operating and Maintenance Costs

Category	Description	Cost
Capital	Field control equipment upgrade	
	Additional surveillance	
	Additional detection	
	Additional DMS	
	Communication upgrade	
Operations and Maintenance	Operators	
	Engineers	
	Maintenance technicians	
	Communications	
	Equipment	

4.6.6 Implementation priorities and schedule

The various strategies should be sequenced for greatest effect. Traffic control systems should be improved before traveler information is given on system operating problems. Infrastructure projects take more time than improved signal timing. Budgets limit the rate at which capital projects can be implemented. Therefore it is important to lay out the corridor plan in a way that maximizes benefits by proceeding in an orderly and logical manner.

4.6.7 Updating process

The corridor plan should be a living document. Steps 10 and 11 of the Coordinated Freeway and Arterial Framework include operations, maintenance, and continuous improvement, which completes, but does not end the process. Continuous improvement should lead to the identification of new problems to address, which feeds into the beginning of the process. Depending on the nature of the new opportunities, will determine which steps in the framework need to be addressed. If the opportunity involves new agencies, then the process needs to begin at the institutional step 2. If the goals of the corridor plan need refinement, then step 3 needs to be revisited. If the Corridor Concept of Operations needs to be expanded or revised, then step 4 needs to be revisited. Once the cycle is begun again, all the subsequent steps should also be visited to determine if the Corridor Plan needs to be updated.

4.7 SUMMARY

The corridor traffic management plan is the culmination of the first seven steps of the Coordinated Freeway and Arterial Framework. The process of utilizing the Coordinated Freeway and Arterial Framework to improve corridor performance assures that the results reflect the institutional needs of the agencies responsible for traffic operations in the corridor. It facilitates the development of appropriate regional traffic management support in order to have the necessary resources. The Corridor Plan is a document that can be used to take project to implementation once the necessary resources are available.

The corridor plan includes the following eleven elements:

1 Goals and objectives
2 Concept of Operations
3 Performance measures
4 Scenarios with operational strategies
5 Roles, responsibilities, and procedures
6 Activation criteria
7 Infrastructure (capital) needs and costs
8 Maintenance requirements and costs
9 Operating resources and costs
10 Implementation priorities and schedule
11 Updating process

The plan should contain sufficient detail to secure funding and take projects to the development of plans, specifications and estimates of cost.

The next three chapters provide additional details on developing specific strategies in response to the four categories of events for which coordinated freeway and arterial operations can be effective:

- Incidents (Chapter 5)
- Work zones (Chapter 6)
- Planned special events (Chapter 7)
- Day-to-day congestion (Chapter 8)

Chapter 9 provides additional detail on supporting technology and ITS elements. This material provides an overview of the technology which would be included in the corridor plan, but which would be specified in detail in the next step in the Coordinated Freeway and Arterial Operations Framework. Following design, projects are deployed, operated, and maintained. As part of the operation process, opportunities for continual improvement are also identified.

[1] Coordinated Operation of Ramp Metering and Adjacent Traffic Signal Control Systems, U.S. Department of Transportation, Federal Highway Administration, Publication No. FHWA-RD-95-130, Washington, D.C., June 1996.